Stone Fort at Fort Totten: Last Habitat for Woodsia obtusa and Asplenium platyneuron in Queens County, Long Island, New York?

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In the course of documenting vegetation on the northeastern coast of Queens County, Long Island, New York, the senior author discovered two ferns, *Asplenium platyneuron* (L.) B.S.P. and *Woodsia obtusa* (Spreng.) Torrey, in what may well be their last remaining habitat in Queens County (Borough of Queens, City of New York). They were found in the weathered cement between large blocks of granite used to construct the walls of the "Stone Fort" at Fort Totten, a 19th Century coastal fortification on the Willets Point peninsula (40°47′30″ N, 73°46′40″ W). The Stone Fort now forms Willets Point, rising from the shore level to a height of thirty feet. It was built in 1862–66 as part of the seacoast defenses of New York City; photographs and a brief history of the Stone Fort were published by Alperstein (1977). Reconnaissances of the site were undertaken in the spring of 1973, in the late spring and early summer of 1978, and during the winter of 1981–82. Occasionally a few plants were measured, but a census was not attempted.

Soil samples were obtained adjacent to fern roots at two sites on the landward side of the granite wall, for elemental analysis. Stones, sticks, and obvious plant matter were separated, and a portion of well-mixed soil was ground in a mortar to a fine powder. A 1.00 g sample of each was dry-ashed at 450°C in a muffle furnace, and a semi-quantitative elemental analysis conducted with a Baird Atomics Emission Spectrograph. A just-saturated slurry in distilled water was made of each raw soil sample, and the pH measured with an Orion combination electrode and a Corning pH meter.

Further tests for sodium and chloride, indicators of saline spray, were made on samples taken near *Woodsia* roots, one from the seaward side of the granite wall, and one from the landward side. Soil samples, 1.00 g, were extracted with 10.0 ml of distilled, deionized water. The sodium content was determined by atomic absorption spectroscopy using a Perkin-Elmer 303, and chloride content by ion-selective electrode using an Orion electrode and a Beckman expanded scale pH meter.

Voucher specimens were deposited at the Herbarium of the Brooklyn Botanic Garden (BKL).

RESULTS

Fewer than twenty-five individuals of *A. platyneuron* were observed during the most recent visit (30 March 1982). These were concentrated around the central stairway connecting the three levels of the fort, between the main and upper levels, in a sheltered, moderately well lighted location. A few individuals were scattered over the rest of the main level. The plants grew from partially decomposed cement

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in joints between granite blocks. They were well rooted in the joints, to perhaps 10 cm deep. Fronds seldom exceeded 10 cm in length.

The population of *W. obtusa* numbered several hundred individuals. Plants occurred in the horizontal joints of the seaward granite wall of the fort, where sea spray and salt-laden air are features of the environment. More commonly, individuals occurred in both vertical and horizontal joints in the complex of granite walls on the main, landward side. Plants of *Woodsia* appeared to be less deeply and securely rooted than those of *Asplenium*. Commonly, young sporophytes were seen attached to gametophytes. *Woodsia* plants in winter bear a rosette of sterile fronds approximately 3–4 cm long. Fertile fronds are produced during the growing season; these regularly reach 30 cm or longer.

The substrate of both ferns consisted of a mixture of black humus and light gray fragments of cement and sands. The soil evidently arises from the mortar decomposed through weathering and from organic materials deposited by the ferns and other organisms which have gained a foothold (Segal, 1969). This is supported by our chemical analyses. The results of the dry-ashing test show that organic materials account for nearly 40% by weight of the soil sample. In addition, the emission spectrographic elemental analyses of the inorganic portions of the wall soil samples reveal silicon, calcium, and aluminum to be the major constituents and an overall composition quite similar to that of Portland cement. Portland cement has been in widescale use since at least 1850 (Lea, 1971), and apparently was used as the mortar for the Stone Fort. Although raw, wet cement is highly alkaline (pH 11–12), acidic agents in rainwater and in humic substances from decayed plant materials act to neutralize the alkalinity. Our soil samples are neutral (pH 6.96–7.00); these pH values are typical of well-aged wall soils (Segal, 1969).

Results of the sodium and chloride analyses, in μg/g of soil (ppm) are: landward, 250 ppm Na and 110 ppm Cl; seaward, 1200 ppm Na and 280 ppm Cl. The seaward wall soil has nearly five times as much sodium and more than twice as much chloride as the soil from the landward wall, confirming the influence of salt spray on the seaward side.

DISCUSSION

It is uncertain when *A. platyneuron* and *W. obtusa* first appeared in the mortar of the Stone Fort. Little of the mortar remains unweathered, and extensive sections are missing. It is possible that the latter sections once supported populations of the ferns. It cannot be decided on the basis of the available data whether it is the high calcium content or the neutral pH of the soil that accounts for the presence of the ferns; both conditions are uncommon on Long Island.

We inspected herbaria at New York Botanical Garden, Brooklyn Botanic Garden, and Planting Fields Arboretum, and consulted with staff of the New York State Herbarium, Albany. *Woodsia obtusa* has been collected at Ridgewood, in Queens County (*G. B. Brainerd* in 1866, BKL 022985); on rocks near Greenport, in Suffolk County, Long Island (BKL 1862); and in "dry woods" there (*R. Latham* in 1918, NY 824). The Fort Totten collection (*Greller* in 1973, BKL) is the first *Woodsia* from stone walls on Long Island. Edward Frankel (pers. comm.) reports *W. obtusa*

as common on old walls in Westchester County, north of Long Island. *Woodsia* was collected "on walls of old ice chute, south side" at Rockland Lake, Clarkstown Township, Rockland County, New York (*J. H. Lehr* in 1954, NY), also north of Long Island. Jelliffe (1899) listed *A. platyneuron* as "frequent throughout Long Island." Nevertheless, Greller (1977, 1979) did not encounter it in the only remaining extensively forested sites in Queens County: Cunningham, Forest, and Alley Parks. Until they are reported elsewhere, the Fort Totten populations of *W. obtusa* and *A. platyneuron* are the only ones documented in Queens County. Their absence from former terrestrial habitats may be caused by a decrease in soil pH, perhaps as a result of acid rain. Precipitation pH in Queens County since 1970 has averaged about 4.0, monthly averages ranging from 3.5 (summer) to 4.5 (spring and fall) (D. C. Locke, unpubl.).

Occurrence of *W. obtusa* on the seaward wall is noteworthy because of the relatively high levels of sodium and chloride which presumably result from salt spray. Based on salinity measurements made in Hempstead Harbor, a similar bay a few miles east of Fort Totten, the salinity of Long Island Sound at Fort Totten is about 25‰ (D. C. Locke, unpubl.), less than that of ocean water (35‰) but more than sufficient to produce saline spray. The relatively higher level of sodium than chloride in both samples presumably reflects differential leaching of the two elements; according to Lindsay (1979), the level of sodium in soils is typically higher than that of chloride.

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